

CLAIMS

The invention claimed is:

1. A method for forming hafnium-containing materials, comprising:
  - providing a semiconductor substrate;
  - utilizing first reaction conditions to form hafnium-containing seed material in a desired crystallographic orientation over the substrate; the desired crystallographic orientation predominately including one or more crystallographic orientations other than a monoclinic orientation;
  - utilizing second reaction conditions different from the first reaction conditions to grow second hafnium-containing material over the seed material; and
  - utilizing the seed material to induce the desired crystallographic orientation in the second hafnium-containing material.
2. The method of claim 1 wherein the desired crystallographic orientation is a tetragonal orientation.
3. The method of claim 1 wherein the second hafnium-containing material is grown in a substantially amorphous phase, and wherein the seed material is utilized to induce both a crystalline phase in the second hafnium-containing material and the desired crystallographic orientation in the second hafnium-containing material.

4. The method of claim 1 wherein the seed material is utilized to induce the desired crystallographic orientation in the second hafnium-containing material after growing the second hafnium-containing material.

5. The method of claim 1 wherein the hafnium-containing seed material consists essentially of hafnium oxide.

6. The method of claim 5 wherein the first reaction conditions comprise utilizing a hafnium chloride reactant to form the hafnium oxide-containing seed material.

7. The method of claim 6 wherein the first reaction conditions comprise exposing the hafnium chloride reactant to a temperature of at least about 350°C during formation of the hafnium oxide-containing seed material.

8. The method of claim 5 wherein the first reaction conditions comprise utilizing a hafnium-containing metal organic reactant to form the hafnium oxide-containing seed material.

9. The method of claim 8 wherein the hafnium-containing metal organic reactant comprises tetrakis dimethyl hafnium or methylethyl tetrakis amidohafnium.

10. The method of claim 8 wherein the first reaction conditions comprise exposing the hafnium-containing metal organic reactant to a temperature of at least about 350°C during formation of the hafnium oxide-containing seed material.

11. The method of claim 5 wherein the second hafnium-containing material consists essentially of hafnium oxide.

12. The method of claim 11 wherein the second reaction conditions comprise:

growing the hafnium oxide of the second hafnium-containing material from a hafnium-containing metal organic reactant while exposing the reactant to a temperature of less than or equal to about 250°C; and

after growing the hafnium oxide of the second hafnium-containing material, exposing the hafnium oxide of the second hafnium-containing material and the hafnium oxide of the hafnium-containing seeds to a temperature of at least about 350°C to induce the desired crystallographic orientation in the hafnium oxide of the second hafnium-containing material.

13. The method of claim 12 wherein the temperature utilized to induce the desired crystallographic orientation in the hafnium oxide of the second hafnium-containing material is at least about 400°C.

14. The method of claim 12 wherein the temperature utilized to induce the desired crystallographic orientation in the hafnium oxide of the second hafnium-containing material is at least about 600°C.

15. A method for forming hafnium oxide, comprising:

- providing a semiconductor substrate;
- forming first hafnium oxide-containing material over the substrate, the first hafnium oxide-containing material predominately having a tetragonal crystallographic orientation;
- forming second hafnium oxide-containing material over the first hafnium oxide-containing material, the second hafnium oxide-containing material being substantially amorphous; and
- utilizing the first hafnium oxide-containing material to induce the tetragonal crystallographic orientation in the second hafnium oxide-containing material.

16. The method of claim 15 wherein the first hafnium oxide-containing material has a thickness of from about 5Å to about 20Å.

17. The method of claim 16 wherein the second hafnium oxide-containing material has a thickness of greater than about 20Å.

18. The method of claim 15 wherein the first hafnium oxide-containing material is formed from a hafnium chloride reactant.

19. The method of claim 15 wherein the first hafnium oxide-containing material is formed from a hafnium-containing metal organic reactant.

20. The method of claim 15 wherein the second hafnium oxide-containing material is formed from a hafnium-containing metal organic reactant while exposing the reactant to a temperature of less than or equal to about 250°C.

21. The method of claim 15 wherein a temperature of the second hafnium oxide-containing material during the inducing of the tetragonal crystallographic orientation in the second hafnium oxide-containing material is at least about 400°C.

22. The method of claim 15 wherein a temperature of the second hafnium oxide-containing material during the inducing of the tetragonal crystallographic orientation in the second hafnium oxide-containing material is at least about 600°C.

23. The method of claim 22 wherein the temperature of at least about 600°C is maintained for at least about one hour.

24. The method of claim 22 wherein the temperature of at least about 600°C is achieved by rapid thermal processing at a rate of at least about 50°C/minute and is maintained for at least about one minute.

25. The method of claim 15 wherein the first hafnium oxide-containing material consists essentially of hafnium oxide.

26. The method of claim 15 wherein the second hafnium oxide-containing material consists essentially of hafnium oxide.

27. The method of claim 15 wherein the substrate includes a surface comprising one or more of tantalum nitride, tungsten nitride and titanium nitride; and wherein the first hafnium oxide-containing material is formed directly against the one or more of tantalum nitride, tungsten nitride and titanium nitride of the surface.

28. The method of claim 15 wherein the second hafnium oxide-containing material is formed over a first capacitor electrode, and further comprising forming a second capacitor electrode over the second hafnium oxide-containing material.

29. The method of claim 28 wherein the second capacitor electrode is formed after utilizing the first hafnium oxide-containing material to induce the tetragonal crystallographic orientation in the second hafnium oxide-containing material.

30. The method of claim 28 wherein the only dielectric material between the first and second capacitor electrodes is the first and second hafnium oxide-containing materials.

31. A method of forming hafnium oxide, comprising:  
providing a semiconductor substrate;  
forming a first hafnium oxide-containing material from a first  
hafnium-containing precursor utilizing a temperature of greater than or equal to  
350°C; and

forming a second hafnium oxide-containing material directly  
against the first hafnium oxide-containing material from a second hafnium-  
containing precursor utilizing a temperature of less than or equal to 250°C.

32. The method of claim 31 wherein the second hafnium-containing  
precursor is the same as the first hafnium-containing precursor.

33. The method of claim 31 wherein the temperature utilized during  
formation of the second hafnium oxide-containing material is from about 150°C  
to about 250°C.

34. The method of claim 31 wherein the first hafnium-containing  
precursor is a hafnium chloride reactant.

35. The method of claim 31 wherein the first hafnium-containing  
precursor is a hafnium-containing metal organic reactant.

36. The method of claim 35 wherein the hafnium-containing metal organic reactant comprises tetrakis dimethylhafnium or methylethyl tetrakis amidohafnium.

37. The method of claim 31 wherein the second hafnium-containing precursor is a hafnium-containing metal organic reactant.

38. The method of claim 37 wherein the hafnium-containing metal organic reactant comprises tetrakis dimethylhafnium or methylethyl tetrakis amidohafnium.

39. The method of claim 31 wherein the first hafnium oxide-containing material has a substantially crystalline phase and has crystallographic orientation, wherein the second hafnium oxide-containing material has a different phase than the first hafnium oxide-containing material; and further comprising inducing a crystallographic phase change within the second hafnium oxide-containing material to cause the second hafnium oxide-containing material to adopt the crystallographic phase and orientation of the first hafnium oxide-containing material; the inducing the crystallographic phase change comprising heating the second hafnium oxide-containing material to a temperature of at least about 400°C.

40. The method of claim 39 wherein the second hafnium oxide-containing material is formed over a first capacitor electrode, and further comprising forming a second capacitor electrode over the second hafnium oxide-containing material.

41. The method of claim 40 wherein the second capacitor electrode is formed after utilizing the first hafnium oxide-containing material to induce the crystallographic phase change in the second hafnium oxide-containing material.

42. The method of claim 40 wherein the only dielectric material between the first and second capacitor electrodes is the first and second hafnium oxide-containing materials.

43. The method of claim 39 wherein the temperature of the second hafnium oxide-containing material during the inducing of the phase change in the second hafnium oxide-containing material is at least about 600°C.

44. The method of claim 31 wherein the first hafnium oxide-containing material consists essentially of hafnium oxide.

45. The method of claim 31 wherein the second hafnium oxide-containing material consists essentially of hafnium oxide.

46. The method of claim 31 wherein the substrate comprises a surface comprising one or more of tantalum nitride, tungsten nitride and titanium nitride; and wherein the first hafnium oxide-containing material is formed directly against the one or more of tantalum nitride, tungsten nitride and titanium nitride of the surface.

47. A capacitor construction, comprising:  
a semiconductor substrate;  
a first capacitor electrode over the semiconductor substrate;  
a second capacitor electrode over the first capacitor electrode; and  
a dielectric material between the first and second capacitor electrodes; an entirety of the dielectric material between the first and second electrodes consisting essentially of crystalline hafnium oxide having a non-monoclinic crystallographic orientation.

48. The capacitor construction of claim 47 wherein the entirety of the dielectric material between the first and second electrodes consists of the crystalline hafnium oxide having the non-monoclinic crystallographic orientation.

49. The capacitor construction of claim 47 wherein the dielectric material between the first and second electrodes has a thickness greater than 25Å.

50. The capacitor construction of claim 47 wherein the non-monoclinic crystallographic orientation is a tetragonal crystallographic orientation.

51. The capacitor construction of claim 47 wherein the first capacitor electrode comprises titanium nitride, and wherein the hafnium oxide of the dielectric material is directly against the titanium nitride of the first capacitor electrode.

52. The capacitor construction of claim 47 wherein the first capacitor electrode comprises tantalum nitride, and wherein the hafnium oxide of the dielectric material is directly against the tantalum nitride of the first capacitor electrode.

53. The capacitor construction of claim 47 wherein the first capacitor electrode comprises tungsten nitride, and wherein the hafnium oxide of the dielectric material is directly against the tungsten nitride of the first capacitor electrode.

54. The capacitor construction of claim 47 wherein the second capacitor electrode comprises titanium nitride, and wherein the hafnium oxide of the dielectric material is directly against the titanium nitride of the second capacitor electrode.

55. The capacitor construction of claim 47 wherein the second capacitor electrode comprises tantalum nitride, and wherein the hafnium oxide of the dielectric material is directly against the tantalum nitride of the second capacitor electrode.

56. The capacitor construction of claim 47 wherein the second capacitor electrode comprises tungsten nitride, and wherein the hafnium oxide of the dielectric material is directly against the tungsten nitride of the second capacitor electrode.

57. The capacitor construction of claim 47 wherein:

the first capacitor electrode comprises titanium nitride;

the hafnium oxide of the dielectric material is directly against the titanium nitride of the first capacitor electrode;

the second capacitor electrode comprises titanium nitride; and

the hafnium oxide of the dielectric material is directly against the titanium nitride of the second capacitor electrode.

58. The capacitor construction of claim 47 wherein:

the first capacitor electrode comprises tantalum nitride;

the hafnium oxide of the dielectric material is directly against the tantalum nitride of the first capacitor electrode;

the second capacitor electrode comprises tantalum nitride; and

the hafnium oxide of the dielectric material is directly against the tantalum nitride of the second capacitor electrode.

59. The capacitor construction of claim 47 wherein:

the first capacitor electrode comprises tungsten nitride;

the hafnium oxide of the dielectric material is directly against the tungsten nitride of the first capacitor electrode;

the second capacitor electrode comprises tungsten nitride; and

the hafnium oxide of the dielectric material is directly against the tungsten nitride of the second capacitor electrode.

60. A DRAM comprising the capacitor construction of claim 47.
61. An electronic system comprising the DRAM of claim 60.